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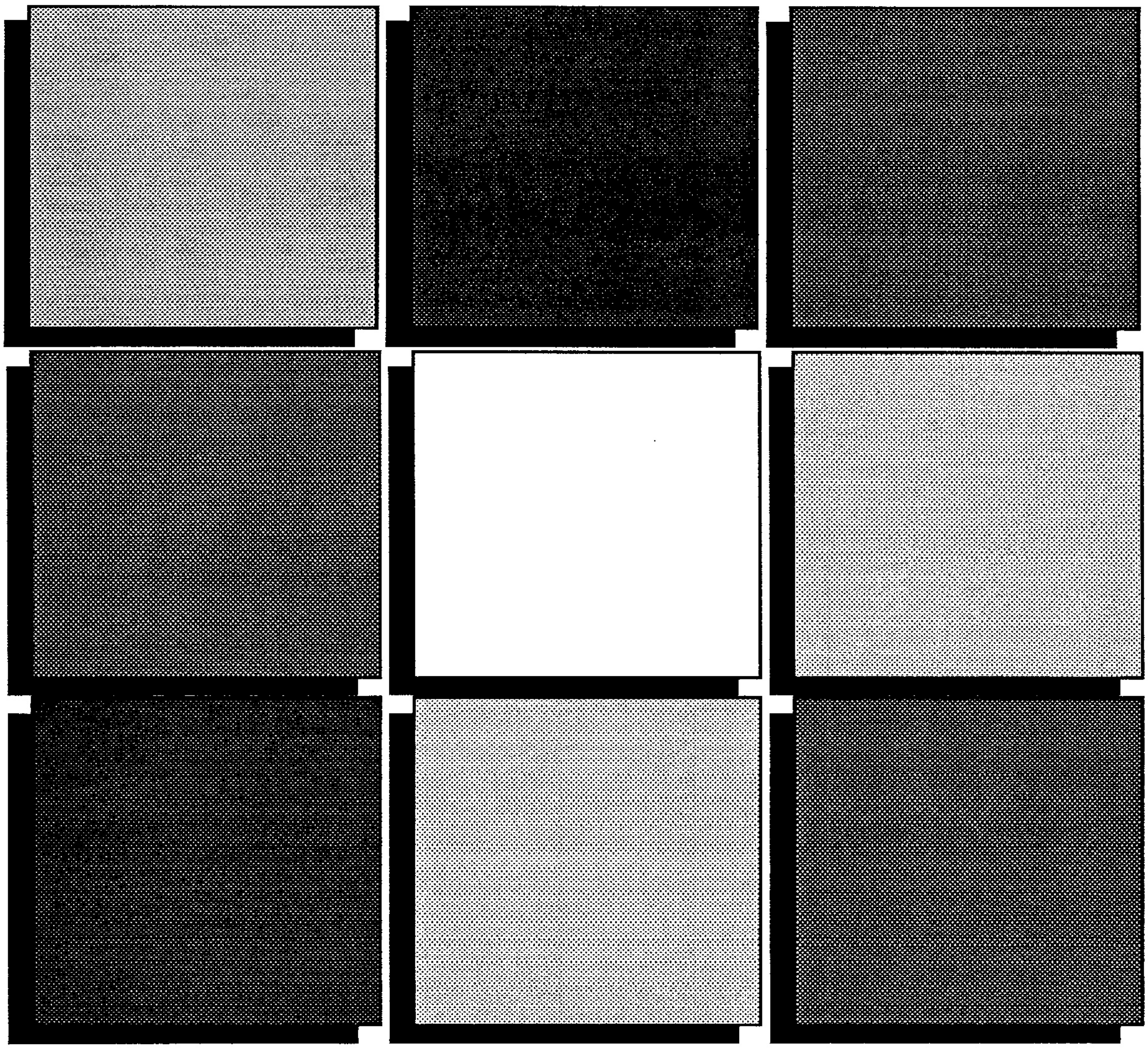

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Ventura Educational Systems

3440 Brokenhill Street
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SuperGraph

SuperGraph
SuperGraph
SuperGraph
SuperGraph

- A sophisticated tool for graphing complex mathematical relationships.
- Built-in constants for solving problems in algebra, trigonometry, calculus and physics.
- Includes a Teacher's Guide and reproducible blackline masters.
- Program Disk and DataDisk with sample graphs.

Ventura Educational Systems

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SuperGraph

The ability to quickly graph complex mathematical relationships is a definite asset in studying algebra, trigonometry and calculus. SuperGraph is a software tool that allows relationships to be defined for f(x) and g(x). It unlocks the power of your computer to represent mathematical functions and can be very useful in mathematics classes.

Common functions are built-in features of SuperGraph and others can be defined by the user. The program internalizes any syntactically correct expression and generates a graph at lightening speed.

Credits

Software Design	**Ventura Educational Systems**
Concept and Programming	**Dominick Cancilla**
Editor	**Fred Ventura, Ph.D.**

Dominick Cancilla is a mathematics and programming specialist. In SuperGraph he has created a unique and creative tool for mathematics instructors and students who want an easy to use program that is able to represent complex mathematical relationships.

Dr. Fred Ventura is an experienced classroom teacher and has taught elementary, secondary and college levels. He holds a doctorate in education from the University of California, and presents workshops for educators on the instructional uses of microcomputers.

Other software products available from Ventura Educational Systems:

Hands-On Math
GeoArt: Geometry and Art Discovery Unit
Marine Life: Anatomy of a Fish
Anatomy of a Sea Lamprey
Senses: Physiology of the Human Sense Organs
The Plant: Nature's Food Factory
Chemaid: Introduction to the Periodic Table
The Worm: Invertebrate Anatomy
Protozoa: Introduction to Microorganisms
States: Geography Study Unit and Database
All About the Solar System
All About Simple Machines
Dr. Know: Experiments in Artificial Intelligence

Coordinate Geometry
Geometry Concepts
Marine Invertebrates
Anatomy of a Shark

VisiFrog: Vertebrate Anatomy
Computer Concepts
Plant and Animal Cells
The Insect World
All About Matter
All About Light & Sound

SuperGraph

General Description

SuperGraph is designed to be a tool for teachers and students. The program allows the user to enter mathematical relationships, from simple linear equations, y=2*x+1, to complex functions, y=sin(x)*cos(x^2), and see the curve produced by the equation graphed on the computer screen.

As students begin the study of higher mathematics they learn about vertically defined functions, f(x). Advanced mathematics students will appreciate the ability to define equations for both f(x) and g(x). Supergraph allows students to open the door to some very interesting graphs (see SuperGraph Demo) and this can provide a deeper insight into the mathematics.

Menu

After the title screen is displayed the SuperGraph menu will appear. The list below explains the functions that special keys have when the menu is active.

To add to the ease of use of SuperGraph several actions have been simplified to one or two key presses. Depending on where in the program the user is certain actions are available. The next section describes what key actions are available in different section of the program.

SuperGraph Main Menu and Demo

Key	Effect
arrows	move indicator.
letter	go to next item beginning with that letter.
<return>	accept current setting or status.
<space>	change columns in demonstration mode or accept in other cases.
esc	move to quit option.

Supergraph Reference

Key	Effect
arrows	move
< and >	page
Q	quit
? or H	get help
-, =	go to next, previous section
P	print current level
<esc>	go to previous section

Read/Write Option

<name>	read or write a SuperGraph data file
<name>.PIC	using the extension ".PIC" causes Supergrapher to read into or write from high resolution graphics page 1
cat or dir	catalog the disk in drive #1 showing directory of files

Equation Editor

When defining an expression for either f(x) or g(x) the following keys are implemented to assist in editing. The definition of functions are stored in a buffer and can be moved in and out of the buffer using the arrow keys, delete and return.

Key	**Effect**
-->	output from buffer
<--	input to buffer
<delete>	erase previous character
<return>	accept

In the equation editor several macros, key sequences that produce a function, are available. Macros are designed to simplify the entry of functions.

Macros	**Function**
CTRL-A	ABS(
CTRL-C	COS(
CTRL-D	SGN(
CTRL-E	EXP(
CTRL-F	ATN(
CTRL-I	INT(
CTRL-J	SQR((down arrow)
CTRL-K	^ (up arrow)
CTRL-L	(
CTRL-N	NOT
CTRL-O	OR
CTRL-P	PI
CTRL-R	RND(
CTRL-S	SIN(
CTRL-T	TAN(
CTRL-X	AND

Using SuperGraph

SuperGraph is designed to encourage high-level mathematical exploration. The following operations, constants and functions are implemented in the program and can be used in defining expressions for f(x), and g(x). The SuperGraph Reference can be selected from the SuperGraph Menu and provides access to information on the operators, constants and functions available in SuperGraph.

Note: When using SuperGraph be sure that the Caps-Lock key on the Apple keyboard is depressed.

Operations

Symbol	Name	Example
+	addition	1+1
-	subtraction	1-1-2
*	multiplication	2*4
/	division	3/5
^	exponentiation	3^2
=	equal	1=2-1
>	greater than	2>1
<	less than	1<2
#	not equal	1#2
E	scientific notation	5E3

Implemented Functions

The functions that are described in this section are implemented in SuperGraph. The sophisticated equation processor used in SuperGraph internalizes syntactically correct functions. The definition of the equation can contain any of the following mathematical functions.

Basic Functions

Function	Description	Example
abs	absolute value	abs(X)
atn	arctangent in radians	atn(X)
cos	cosine in radians	cos(X)
exp	Euler's constant to the power of X	exp(x)
int	largest integer less than or equal to a value	int(x)
log	natural logarithm	log(x)
rnd	random number greater than or equal to zero and less than one	rnd(x)
sgn	-1 if the value is negative, 1 if the value is positive and 0 if the value is zero	sgn(x)
sin	sine in radians	sin(x)
sqr	square root	sqr(x)
tan	tangent in radians	tan(x)

Extended Functions

The extended functions listed below can used equations. Each function begins with the @ symbol.

Function	Description	Example	Formula
@arccos	inverse cosine	@arccos(x)	(-atn(x/sqr(-x^-2+1))+pi/2)
@arccosh	inverse hyper-bolic cosine	@arccosh(x)	log(x+sqr(x^2-1))
@arccot	inverse cotangent	@arccot(x)	(-atn(x)+pi/2)
@arccoth	inverse hyperbolic cotangent	@arccoth	log((x+1)/(x-1))/2
@arccsc	inverse cosecant	@arccsc(x)	(atn(1/sqr(x^2-1)+(sgn(x)-1)*pi/2)
@arccsch	inverse hyperbolic cosecant	@arccsch(x)	log(sgn(x)*sqr(x+1)+1)/2
@arcsec	inverse secant	@arcsec(x)	(atn(sqr(x^2-1))+(sgn(x)-1)*pi/2)
@arcsech	inverse hyperbolic secant	@arcsech(x)	log(sqr(-x^2+1)+1/x
@arcsin	inverse sine	@arcsech(x)	atn(x/sqr(-x^2+1))
@arcsinh	inverse hyperbolic sine	@arcsinh(x)	log(x+sqr(x^2+1))
@arctanh	inverse hyperbolic tangent	@arctanh	log((1+x)/(1-x))/2
@cosh	hyperbolic cosine	@cosh(x)	(exp(x)+exp(-x))/2
@cot	cotangent	@cot(x)	1/tan(x)
@coth	hyperbolic cotangent	@coth(x)	(exp(-x)/(exp(x)-exp(-x))*2+1)
@csc	cosecant	@csc(x)	1/sin(x)
@csch	hyperbolic cosecant	@csch(x)	2/(exp(x)-exp(-x))

@log	base 10 log	@log(x)	log(x)/log(10)
@rnd	random number between 0 and the value of X	@rnd(x)	int(x*rnd(1))
@sec	secant	@sec(x)	1/cos(x)
@sech	hyperbolic secant	@sech(x)	(2/exp(x)+exp(-x)))
@sinh	hyperbolic sine	@sinh(x)	(exp(x)-exp(-x))/2
@tanh	hyperbolic tangent	@tanh(x)	(-exp(-x)/(exp(x)+exp(-x))*2+1)

Conversions

Conversions can be performed automatically by expressing the conversion as a function when using the equation editor.

Function	Description	Example	Formula
@D]G	converts from degrees to gradients	@D]G(x)	10*x/9
@D]R	converts from degrees to radians	@D]R(x)	Pi*x/180
@G]D	converts from gradients to degrees	@G]D(x)	.1*x
@G]R	converts from gradients to radians	@G]R(x)	x*pi/200
@R]D	converts from radians to degrees	@R]D(x)	180*x/pi
@R]G	converts from radians to gradients	@R]G	200*x/pi

Built-in Constants

Several values frequently used as constants in formulas are provided as built-in constants. These constants are commonly used in solving problems.

C	speed of light in miles/second	186,282
CM	speed of light in meters/second	299,792,458
E	Euler's constant	2.71828182
EO	permativity constant	8.854E-12
EV	electron volt in joules	1.60218E-19
G	gravitational constant in feet	32
GM	gravitational constant in meters cubed per KG-second squared	6.672E-11
H	Plank's constant in joules/second	6.626E-34
K	Coulomb's constant in newton-meters squared per coulomb squared	8.988E9
KB	Boltsmann's constant	1.38066E-23

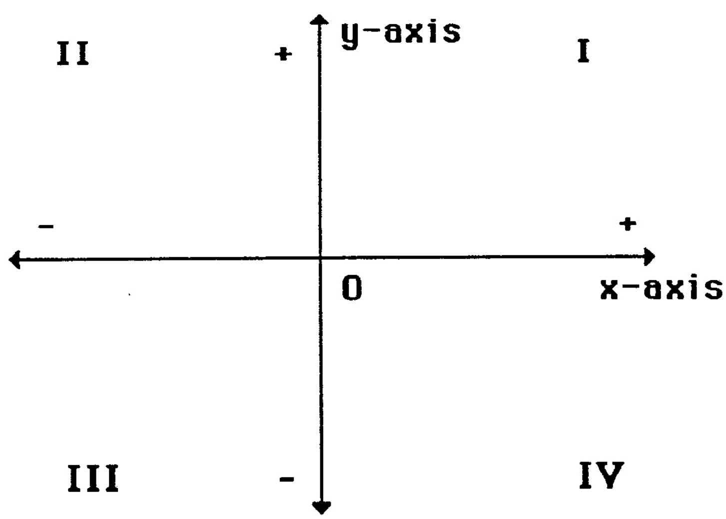
Error Messages

Illegal quantity
/0 (division by 0)
illegal file name (file not found, wrong disk)
disk full
I/O error (drive open, bad disk, no disk)
remove write protect tab (disk write protected)
syntax (illegal characters, mismatched parenthesis)

Coordinate Systems

Two straight lines drawn in the same plane and perpendicular to each other intersect at what is called the origin. The origin can be used to establish the relative position of points on the plane. These lines are called the axes. The horizontal axis is referred to as the x-axis and the vertical axis is called the y-axis. Any point can be defined using an abscissa (x-coordinate) and an ordinate (y-coordinate).

The axes divide the plane into four distinct regions which are called quadrants. The quadrants are labelled as shown.



Functions are the numerical dependence of one quantity on one or more other quantities. For example the area of a square is a function of the length of the side. In strict mathematical interpretations y is described as a function of x if there is a corresponding value relative to the y axis for each point on the x-axis. The notation y=f(x) is read y is equal to f of x. The x term is called the argument and is the independent variable. The dependent variable is the y-term since it depends on x.

x is said to vary continuously if it can take all the values in an interval, for example -1 and +1. The function y=f(x) is said to be continuous at a point x_0 in the given interval if as x approaches x_0, y yields a finite value which is equal to $f(x_0)$.

Graphs are an excellent way to represent a continuous function where a single independent variable is used to produce a curve. Graphs provide insight into the relationship of y and x.

SuperGraph Options

Each graph produced by SuperGraph can be defined using these options:

Ticks
Ticks are the tiny marks that appear on the x and y axes. The ticks are used to help determine values of points on the line that is plotted. The value that is set for ticks determines how many marks for each unit. The size of the unit is set by the Scale option.

Scale
The scale of the graph is determined by the setting given to this variable. Each dot on the computer screen is called a pixel. The scale setting determines how many pixels define one unit. If the scale is 10 then 1 unit on the graph is 10 pixels.

First X
Last X
First X and Last X are used to define the domain for the graph. The domain is set of numbers between lowest x value and the highest x value.

Accuracy
The accuracy factor is a percentage value that determines how many points are used to define the graph.

Pre-define
The Pre-define option controls whether or not the coordinates are displayed or printed before the graph is drawn.

Noise
The Noise option controls whether the computer produces a click when each point is plotted.

Color Set
The Color Set option determines how the graph looks. If the color set is white the graph is drawn in white on a black background. If the color set is switched to black, then the graph is drawn with black on a white background.

Erase Previous Graph
In the study of mathematics it is often desirable to plot more than one function on the same grid. This option is used to control whether the screen is erased before a function is plotted.

Name ______________________________ Date ____________

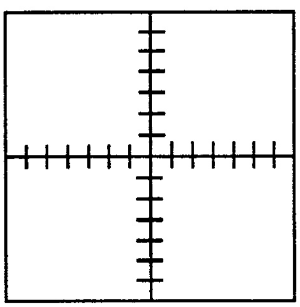
Graphing Solutions *1st degree (linear equations)*

For the activities on this page set up the SuperGraph options as shown:

To set an option move the highlight bar with the arrow keys or press the first letter of the option, then press return. Enter the changes then press return again.

Tick	1
Scale	10
First X	-10
Last X	10
Accuracy	55
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	No

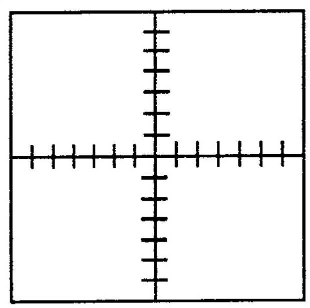
Set the Vertical Equation for the functions shown and sketch the graph produced by each function.



f(x) = x + 3

f(x) = 2*x-4

f(x) = -2*x+3

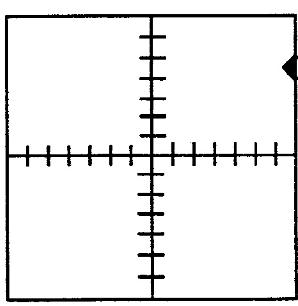


f(x) = $\frac{1}{2}$ * x - 3

f(x) = 2 * x +4

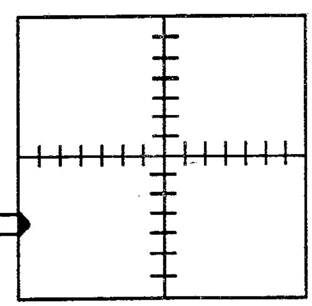
f(x) = -2 * x -1

Use SuperGraph to find the points of intersection for each of these pairs of lines:



f(x) = x + 3	f(x) = -x +2

f(x) = -x + 1	f(x) = 2*x +3



Name ______________________ Date ____________

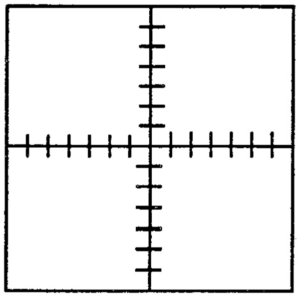
Graphing Solutions — *2nd degree (quadractic equations)*

Write the solutions, x_1 and x_2 for these quadratic equations:

Tick: 1
Scale: 10
First X: -10
Last X: 10
Accuracy: 55
Pre-define: No
Noise: Yes
Color Set: White
Erase Previous Graph: No

f(x)=x^2+x-3 | f(x)=x^2-x-3

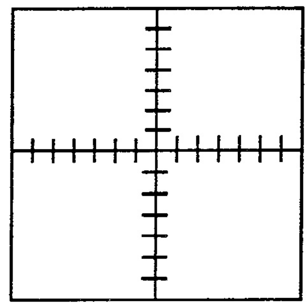
x_1	
x_2	



f(x)=x^2+3*x-1 | f(x)=-1*(x^2+3*x-1)

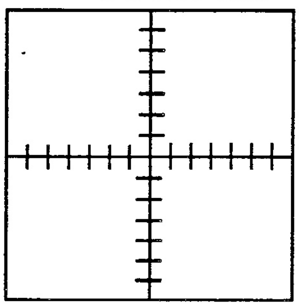
x_1	
x_2	

What if the quadratic is multiplied by -1?



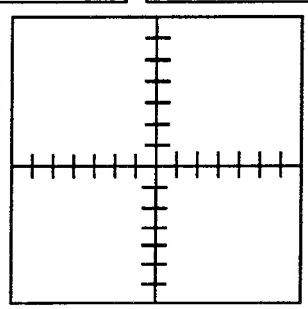
f(x)=2*x^2-x-4 | f(x)=0.5*x^2-x-3

x_1	
x_2	



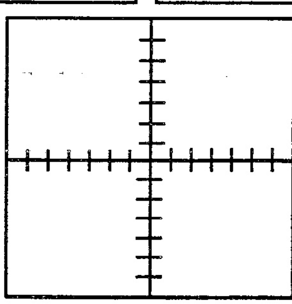
f(x)=x^2-9 | f(x)= x^2-16

x_1	
x_2	



f(x)=x^2-x-4 | f(x)=x^2-3*x-4

x_1	
x_2	



In a pure quadratic equation the two solutions differ only in sign.

Name ______________________________ Date ______________

Graphing Solutions *3rd degree (cubic equations)*

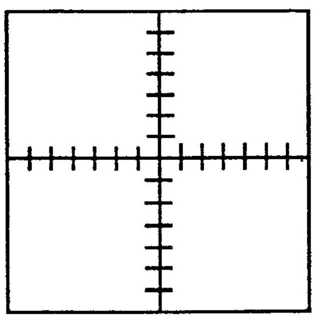
Set Up

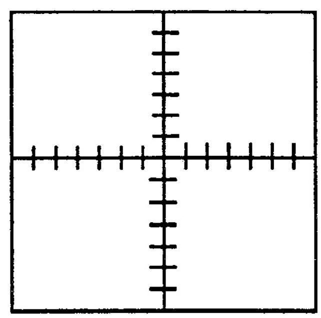
Tic	1
Scale	100
First X	-2
Last X	2
Accuracy	100
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	No

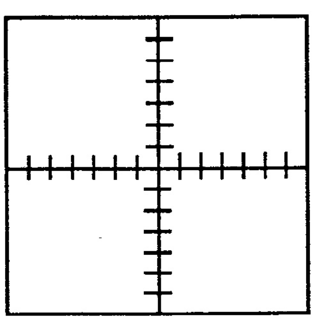
Graph each third degree equation given below.

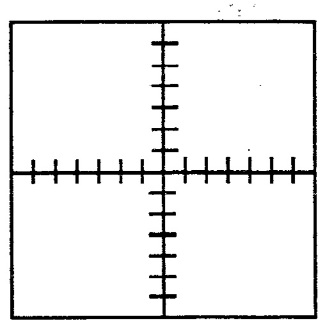
$y=x^3$
$y=x^3-x^2$
$y=x^3-x^2-x$
$y=x^3-x^2-x+1$

Using the set up given above plot these curves with SuperGraph. Write the function on the line and sketch the curves on the graphs given below.









Name ____________________ Date ____________

Graphing Solutions — *4 th degree (biquadratic equations)*

Use this setup to plot these 4th degree equations:

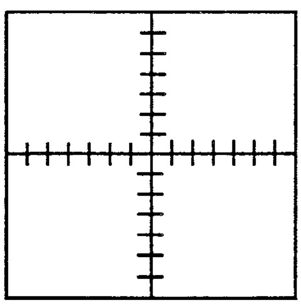
Tic	1
Scale	10
First X	-10
Last X	10
Accuracy	70
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	No

$$x^4 - x^3 + 2x^2 - x + 1 = 0$$

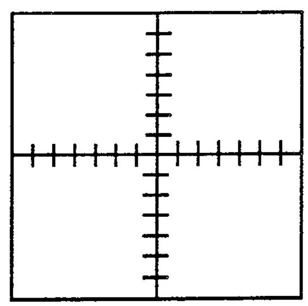
4th degree equations are called biquadratic equations.

Use SuperGraph to plot these equations. Sketch the results.

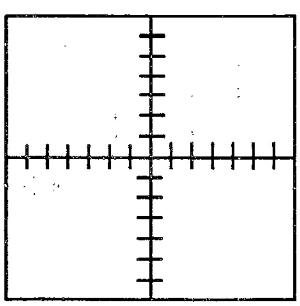
y= x ^ 4 - 3 * x ^ 3 + x ^ 2 + x - 1



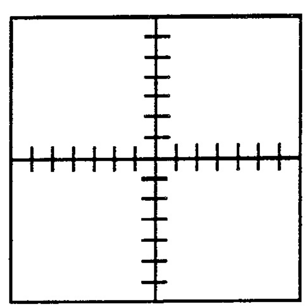
y= x ^ 4 - 2 * x ^ 3 + x ^ 2 + x -4



y= x ^ 4 - 2 * x ^ 3 + x ^ 2 + x -4



y = 3*x ^4 - 2 * x ^ 3 - x ^ 2 - x-1



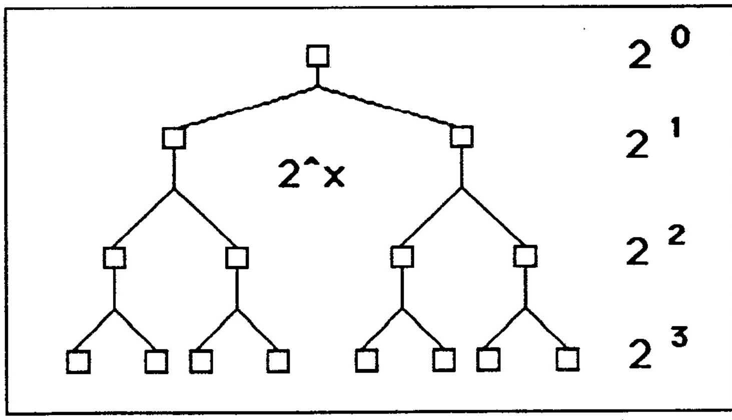
Combine the terms in these equations and graph the results.

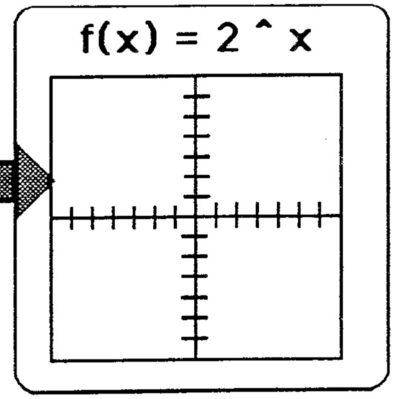
y=x^3+3*x^2+4x^4+2	y=x^2-x^4-x^3-4*x^3-3*x^2-1

Name ______________________________ Date______________

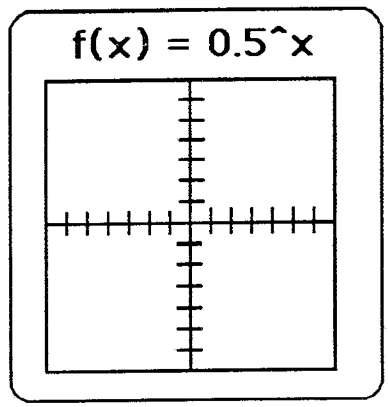
Graphing Solutions *transcendental equations: exponential*

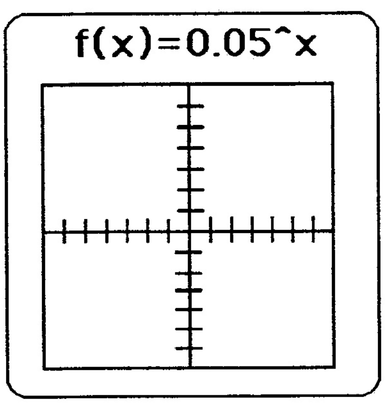
Algebraic equations which contain transcendental functions of the unknown are called transcendental equations. Graph these equations using SuperGraph and sketch the results.

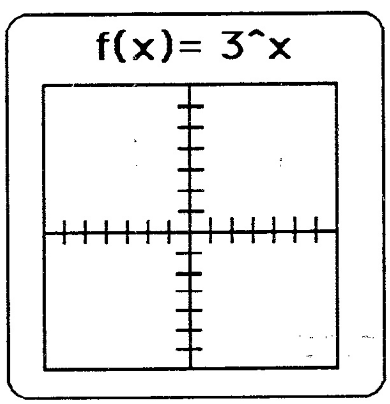


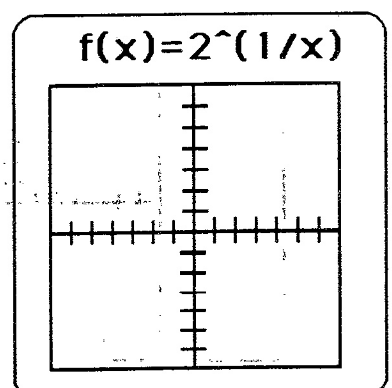


Tic	1
Scale	10
First X	0
Last X	4
Accuracy	55
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	Yes









Set first x to 0.01 in order to avoid division by 0 error.

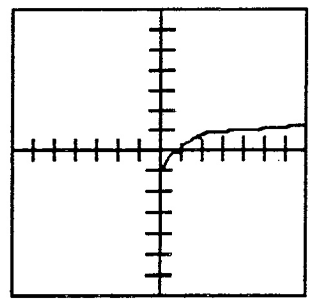
Name ______________________________ Date______________

Graphing Solutions *transcendental equations: logarithmic*

The SuperGraph equation processor has two logarithmic functions, LOG(X) and @LOG(X). The LOG(X) function returns the natural logarithm and the @LOG(X) function returns the base 10 log.

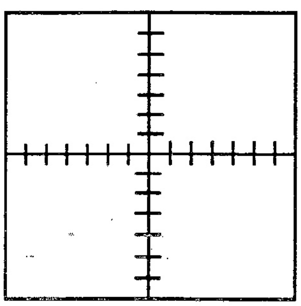
Tic	1
Scale	10
First X	0.1
Last X	20
Accuracy	55
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	Yes

y=log(x)

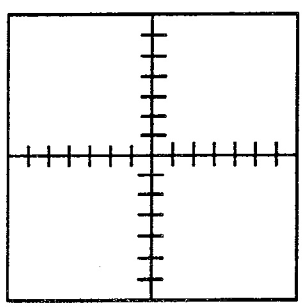


Use SuperGraph to sketch the graph of these logarithmic functions. Set the First X option to 1.1

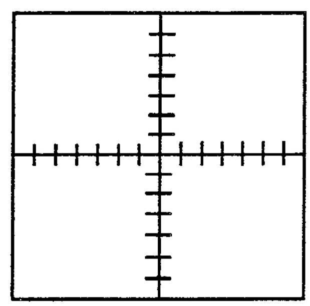
1/log(x)



3*log(x)
- 3*log(x)

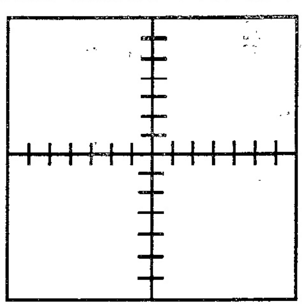


@log(x)



y=log(x)

y=exp(x)

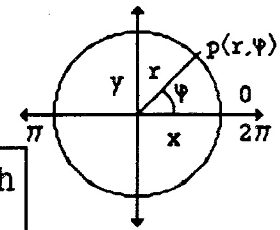


The natural logarithm f(x)=log(x) is defined as the inverse of the exponent function. Graph the natural log and the exponent function for all values of x between .1 and 10. Sketch the graph in the box to the left.

Name ______________________________ Date ______________

Graphing Solutions *trigonometric functions*

SuperGraph has the capability to graph several trigonometric functions. These exercises introduce the trigonometric functions, but a great deal can be learned by experimenting. Trigonometric functions return values in radians. The result of a trigonometric function can be converted to degrees using the @R]D(x) function.



Tick	P8
Scale	40
First X	0
Last X	PI
Accuracy	90
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	No

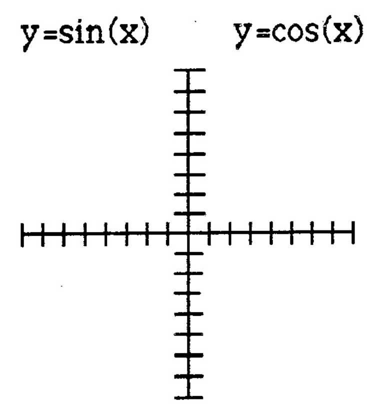
This tells SuperGraph to compute PI/8.

Try these functions:

y=sin(x)^2

y=cos(x)^2

Graph, sketch and label these basic trigonometric functions.



SuperGraph can be used to solve equations. Here is an example:

$$x - \frac{2}{3} = \sin(x)$$

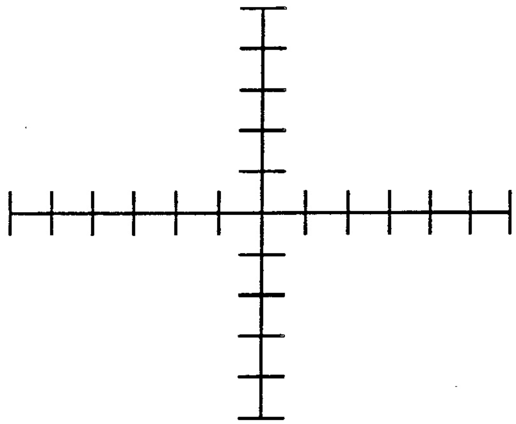
To graphically solve this equation, first plot the sine function using **SIN(X)**. Next plot the function **Y=X-(2/3)*PI**. Observe the point on the graph where the sine curve and the line cross. The x-coordinate of this point is approximately 2.6, the solution!

Name ______________________________ Date ______________

Graphing Solutions *trigonometric functions*

SuperGraph has the basic trigonometric functions, sine, cosine and tangent, but can also accept most other trigonometric functions. Try these experiments which use some of the special trigonometric functions.

Tick	1
Scale	20
First X	-PI
Last X	PI
Accuracy	90
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	No

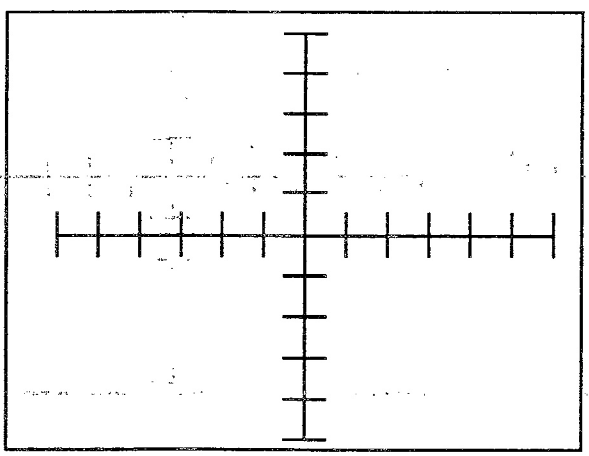


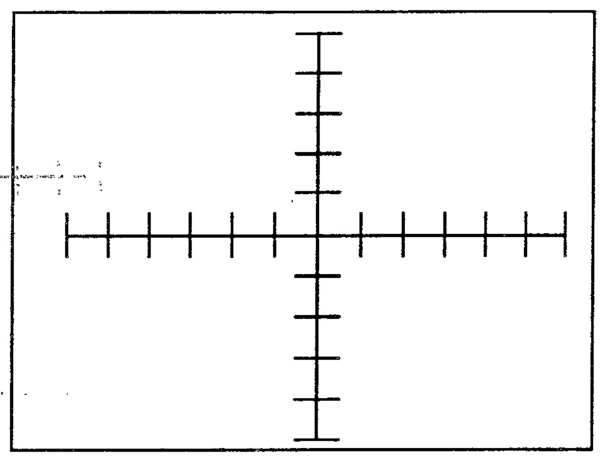
Sketch the curve produced by these function:

f(x) = @ARCCOS(X) inverse cosine
f(x) = @ARCCOT(X) inverse cotangent
f(x) = @ARCSIN(X) inverse sine

For these functions set the first x to .01 and the last x to pi (3.14)

f(x) = @COSH(X) f(x) = CSC(X)
f(x) = @COSH(X) f(x) = CSCH(X)





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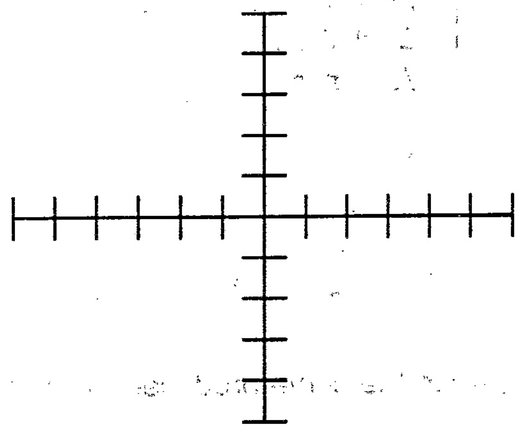
Graphing Solutions — *int(x), rnd(x) and sqr(x) functions*

The integer function, int(x) returns the largest integer less than or equal to the value within the parentheses.

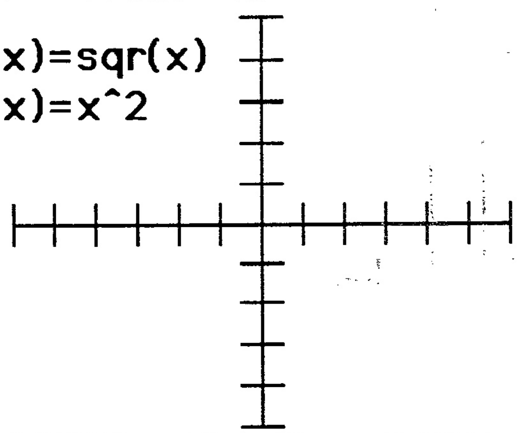
Tick	1
Scale	20
First X	-10
Last X	10
Accuracy	90
Pre-define	No
Noise	Yes
Color Set	White
Erase Previous Graph	No

Try this function: **f(x)=int(x/2)**

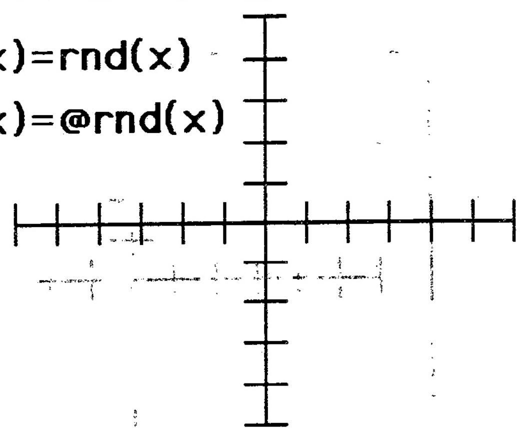


On the left use SuperGraph to overlay the square root function, SQR(X) on a graph of X^2. Set the first x to 0 to avoid an error by trying to compute the square root of a negative number. On the right use SuperGraph's built in random functions. The RND(X) function returns a value greater than 0 and less than 1. The @RND(X) returns a value between zero (0) and the number (x).

f(x)=sqr(x)
f(x)=x^2



f(x)=rnd(x)
f(x)=@rnd(x)



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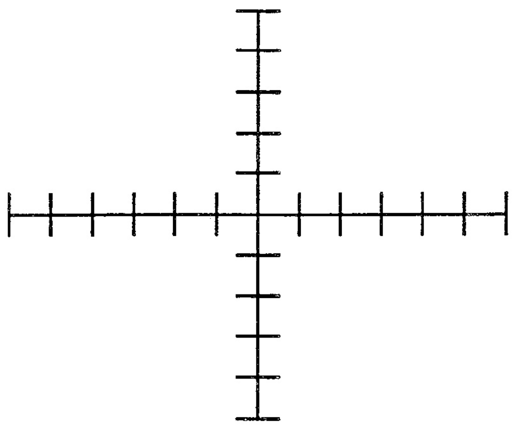
Graphing Solutions *explorations*

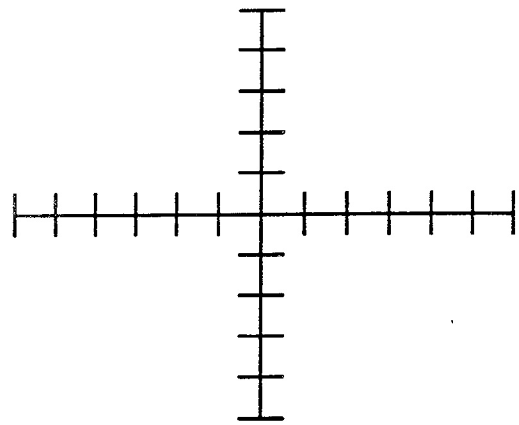
g(x)=

f(x)=



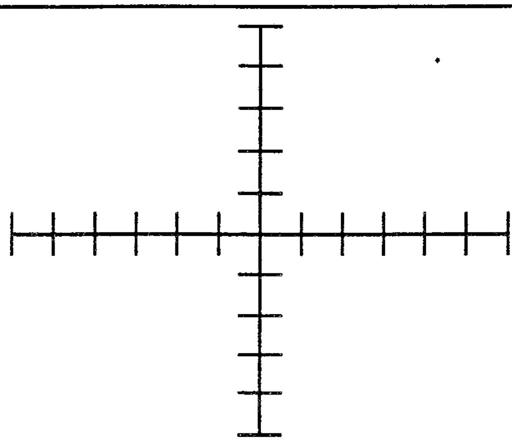
g(x)=

f(x)=



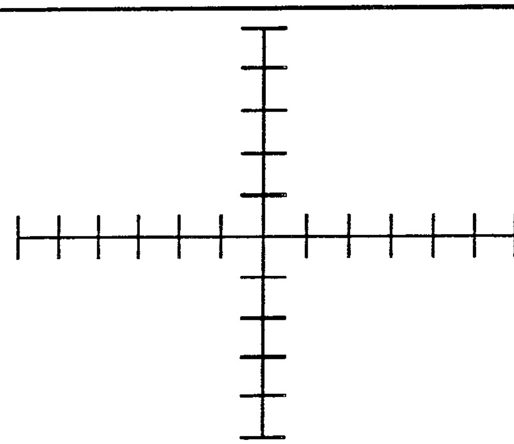
g(x)=

f(x)=



g(x)=

f(x)=



ABS	SGN	@ARCCOTH	@COSH	@SECH	
ATN	SIN	@ARCCSC	@COT	@SINH	
COS	SQR	@ARCCSCH	@COTH	@TANH	
EXP	TAN	@ARCSEC	@CSC	@D]G	
INT	@ARCCOS	@ARCSECH	@LOG	@D]R	@R]D
LOG	@ARCCOSH	@ARCSINH	@RND	@G]D	@R]G
RND	@ARCCOT	@ARCTANH	@SEC		

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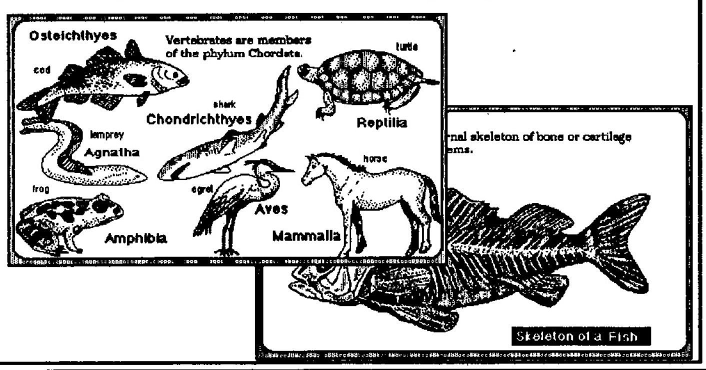

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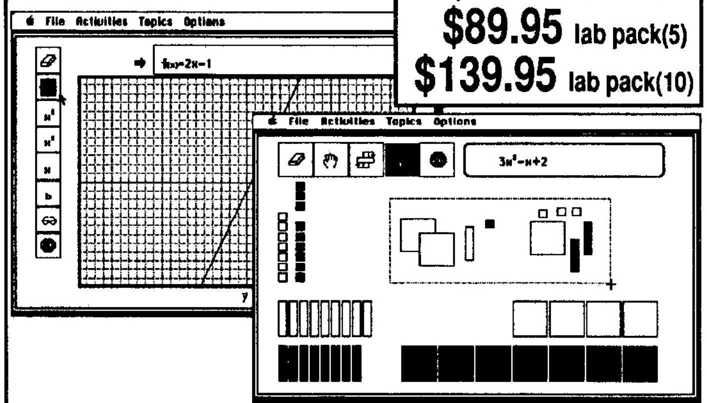

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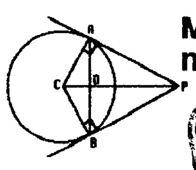

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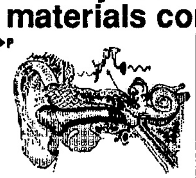

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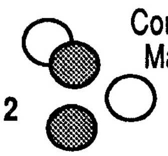

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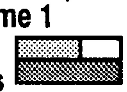

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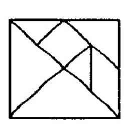

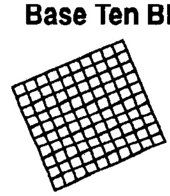

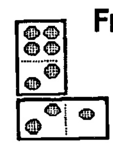

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